so related to each other as to satisfy equation (6) increases enormously the weight of the conclusion and seems to exclude the possibility that it should be the consequence of an obscure and unsuspected systematic error.

We desire to express our great obligation to Miss Wolfe of the Computing Division who has executed most efficiently the numerous least-squares solutions required for the discussion of the data.

[1] Hale, G. E., *Terr. Mag., Baltimore*, **17**, 1912 (173–178); *Mt. Wilson Contr.* No. 71, *Astroph. J., Chicago*, **38**, 1913, (27–98).

[2] Seares, F. H., *Mt. Wilson Contr.* No. 72, *Astroph. J., Chicago*, **38**, 1913, (99–125).

RESONANCE AND IONIZATION POTENTIALS FOR ELECTRONS IN CADMIUM, ZINC, AND POTASSIUM VAPORS[1]

By John T. Tate and Paul D. Foote

University of Minnesota and Bureau of Standards

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It has been shown by Franck and Hertz and others that there are, for electrons accelerated through gases or vapors, certain definite potentials at which there is a large transfer of energy from the electron to the atom, as evidenced by the emission at these potentials of radiations characteristic of the gas atom. This is to be expected on purely mechanical grounds since no considerable transfer of energy from the light electron to the relatively heavy gas atom can take place except when the time of encounter between electron and atom bears some simple relation to the characteristic period of one of the vibrational degrees of freedom in the atom. It is therefore to be expected that there will be a critical potential corresponding to each absorption line of the gas and that at this potential the electrons will give up their energy to the gas and cause the emission of a radiation of the frequency of the corresponding absorption line.

Two types of inelastic encounter between electrons and gas atoms have been observed. One of these results in the emission of a radiation of a single frequency, without ionization of the gas, while the other ionizes the gas and causes it to emit a composite spectrum of radiations. The potential giving the first type of encounter may be termed a resonance potential, that giving the second type an ionization potential.

The present paper is an account of an experimental determination of the resonance and ionization potentials in cadmium zinc, and potassium vapors.

The method employed was that described by Tate[2] for the determination of critical potentials in mercury vapor and the apparatus was similar to that used by us[3] in our work on sodium vapor.

The results obtained are shown in the accompanying table which also contains for the sake of completeness the results, already published, for sodium vapor.

METAL	RESONANCE POTENTIAL (VOLTS)		WAVE LENGTH OF RADIATION	IONIZATION POTENTIAL (VOLTS)		LIMITING WAVE LENGTH OF SERIES
	Observed	Calculated	Å	Observed	Calculated	Å
Cadmium	3.88	3.79	3260.17	8.92	8.97	1378.69
Zinc	4.10	4.02	3075.99	9.50	9.37	1319.95
Potassium	1.55	1.65	7685.0	4.10	4.33	2856.0
Sodium	2.12	2.10	5893.0	5.13	5.13	2413.0

The curves for zinc vapor indicate the possible presence of a secondary inelastic encounter, apparently without ionization, at 2.3 volts; but further work is in progress to make sure of this point.

It will be seen that in all cases the results agree within the limits of experimental error with the values as calculated from the quantum relation $h\nu = eV$, where ν is the frequency of the single radiation in the case of resonance potentials or the limiting frequency of the series of radiations in the case of ionization potentials.

It is to be expected that the frequencies corresponding to the ionization potentials should be the long wave-length limit of the photo-sensibility of the vapor in question. Experiments are now in progress to determine whether or not this is so.

Concerning the question of the cause for the appearance of ionization in metallic vapors at applied potentials much lower than the ionization potential it should be remarked that in no case was there an observable decrease in the value of the resonance potential even under conditions which permit of the appearance of the complete spectrum at low potentials. It is therefore thought that this setting in of ionization at applied potentials much lower than the ionization potential is due rather to the presence of electrons having high initial velocities than to a decrease in the value of the critical potentials. The curves obtained with potassium vapor clearly show the presence of a large number of electrons having initial velocities corresponding to 1.6 volts.

[1] Abstract of a paper presented before the American Physical Society, December 1, 1917.

[2] Tate, *Physic. Rev. Ithaca, N. Y.*, **10,** 1917, (81).

[3] Tate and Foote, *Washington, J. Acad. Sci.*, **7,** 1917, (517).